[1] CEPT/ERC Recommendation T/R 01-08: "Procedures for type testing and approval for radio equipment intended for non-public systems".

[2] (CEPT/ERC Recommendation ERC XX-XX: "Use of Short Range Devices (SRD) using integral antennas and operating in harmonised frequency bands".)

[3] CCITT Recommendation O.153: "Basic parameters for the measurement of error performance at bit rates below the primary rate".

[4] EN 55022: "Limits and methods of measurement of radio disturbance characteristics of information technology equipment".

[5] CISPR publication 16: "Specifications for radio interference measuring apparatus and measurement methods".

[6] ETR 028: "Radio equipment and Systems (RES); Uncertainties in the measurement of mobile radio equipment characteristics".

3 Definitions, abbreviations and symbols

3.1 Definitions

For the purposes of this I-ETS the following definitions apply:

Alarm: the use of radio communication for indicating an alarm condition at a distant location.

Artificial antenna: a tuned reduced-radiating dummy load equal to the nominal impedance specified by the applicant.

Assigned frequency band: the frequency band within which the device is authorised to operate.

Conducted measurements: measurements which are made using a direct connection to the equipment under test.

Fixed station: equipment intended for use in a fixed location.

H-field test antenna: an electrically screened loop or equivalent antenna, with which the magnetic component of the field can be measured.

Identification system: equipment consisting of a transmitter(s), receiver(s) (or a combination of the two) and an antenna(s) to identify objects by a transponder.

Integral antenna: an antenna designed as an indispensable part of the equipment, with or without the use of an antenna connector.

Magnetic Moment: the product of (Number of coil turns) * (coil area) * (coil current). (Air coils only)

Mobile station: equipment normally installed in a vehicle.

Portable station: equipment intended to be carried.

Radiated measurements: measurements which involve the absolute measurement of a radiated field.

Telecommand: the use of radio communication for the transmission of signals to initiate, modify or terminate functions of equipment at a distance.

Telemetry: the use of radio communication for indicating or recording data at a distance.

Transponder: a device, that responds to an interrogation signal.

3.2 Abbreviations

For the purposes of this ETS, the following abbreviations apply:

EMC	Electro-Magnetic Compatibility
ETR	ETSI Technical Report
IF	Intermediate Frequency
ISM	Industrial, Scientific and Medical
RF	Radio Frequency
Rx	Receiver
SRD	Short Range Device
Tx	Transmitter
VSWR	Voltage Standing Wave Ratio

3.3 Symbols

For the purposes of this ETS the following symbols apply:

E	Electrical field strength
Ec	Reference electrical field strength, (see annex A)
f	Frequency
H	Magnetic field strength
Hc	Reference magnetic field strength, (see annex A)
M	Magnetic dipole moment
P	Power
R	Distance
Rc	Reference distance, (see annex A)
t	Time

4 General requirements

4.1 Presentation of equipment for testing purposes

Each equipment submitted for testing shall fulfil the requirements of this ETS on all frequencies over which it is intended to operate.

The applicant shall complete the appropriate application form when submitting the equipment for testing. Also the applicant shall declare the frequency ranges, the range of operation conditions and power requirements, as applicable, to establish the appropriate test conditions.

Additionally, technical documentation and operating manuals shall also be supplied.

Test fixtures may also be supplied by the applicant (see subclauses 6.3 and Annex F)

If an equipment is designed to operate with different carrier powers, measurement of each transmitter parameter shall be performed, according to this ETS, on samples of equipment defined in subclause 4.1.1.

4.1.1 Choice of model for testing

The applicant shall provide one or more samples of the equipment, as appropriate for testing.

Stand alone equipment shall be offered by the applicant complete with any ancillary equipment needed for testing.

If an equipment has several optional features, considered not to affect the RF parameters then the tests need only to be performed on the equipment configured with that combination of features considered to be the most complex, as proposed by the applicant and agreed by the test laboratory.

4.2 Mechanical and electrical design

4.2.1 General

The equipment submitted by the applicant, should be designed, constructed and manufactured in accordance with sound engineering practice and with the aim of minimising harmful interference to other equipment and services.

Transmitters and receivers may be individual or combination units.

4.2.2 Controls

Those controls which, if maladjusted, might increase the interfering potentialities of the equipment shall not be easily accessible to the user.

4.2.3 Transmitter shut-off facility

If the transmitter is equipped with an automatic transmitter shut-off facility, it should be made inoperative for the duration of the test.

4.2.4 Receiver mute or squelch

If the receiver is equipped with a mute, squelch or battery-saving circuit, this circuit shall be made inoperative for the duration of the tests.

4.2.5 Marking (equipment identification)

The equipment shall be marked in a visible place. This marking shall be legible and durable.

4.2.5.1. Equipment identification

The marking shall include as a minimum:

- the name of the manufacturer or his trade mark;
- the type designation.

4.2.5.2 Regulatory marking

The equipment shall be marked, where applicable, in accordance with CEPT/ERC Recommendation T/R 01-03 [1]. Where this is not applicable the equipment shall be marked in accordance with the National Regulatory requirements.

4.3 Declarations by the applicant

When submitting equipment for type testing, the applicant shall supply the necessary information according to the appropriate application form.

The performance of the equipment submitted for type testing shall be representative of the performance of the corresponding production model.

4.4 Auxiliary test equipment

All necessary test signal sources and set-up information shall accompany the equipment when it is submitted for type testing.

4.6 Interpretation of the measurement results

The interpretation of the results recorded on the appropriate test report for the measurements described in this ETS shall be as follows:

- the measured value relating to the corresponding limit shall be used to decide whether an equipment meets the requirements of the ETS;
- the measurement uncertainty value for the measurement of each parameter shall be included in the test report;
- the recorded value of the measurement uncertainty shall be, for each measurement, equal to, or lower than, the figures in the table of measurement uncertainty (clause 9).

5 Test conditions, power sources and ambient temperatures

5.1 Normal and extreme test conditions

Type testing shall be made under normal test conditions, and also, where stated, under extreme test conditions.

The test conditions and procedures shall be as specified in subclauses 5.2 to 5.4.

5.2 External test power source

During type tests, the power source of the equipment shall be replaced by an external test power source capable of producing normal and extreme test voltages as specified in subclauses 5.3.2 and 5.4.2. The internal impedance of the external test power source shall be low enough for its effect on the test results to be negligible. For the purpose of the tests, the voltage of the external test power source shall be measured at the input terminals of the equipment.

For battery-operated equipment the battery shall be removed and the external test power source shall be suitably de-coupled and applied as close to the equipment battery terminals as practicable. For radiated measurements any external power leads should be so arranged so as not to affect the measurements. If necessary, the external power supply may be replaced with the supplied or recommended batteries for the equipment at the required voltage; this shall be stated on the test report. For radiated measurements on portable equipment with integral antenna, fully charged internal batteries should be used. The batteries used should be as supplied or recommended by the applicant.

During tests the test power source voltages shall be within a tolerance $< \pm 1$ % relative to the voltage at the beginning of each test. The value of this tolerance can be critical for certain measurements. Using a smaller tolerance will provide a better uncertainty value for these measurements.

If internal batteries are used, at the end of each test the voltage shall be within a tolerance of $< \pm 5$ % relative to the voltage at the beginning of each test.

5.3 Normal test conditions

5.3.1 Normal temperature and humidity

The normal temperature and humidity conditions for tests shall be any convenient combination of temperature and humidity within the following ranges:

- temperature +15°C to +35°C;
- relative humidity 20 % to 75 %.

When it is impracticable to carry out tests under these conditions, a note to this effect, stating the ambient temperature and relative humidity during the tests, shall be added to the test report.

5.3.2 Normal test power source

5.3.2.1 Mains voltage

The normal test voltage for equipment to be connected to the mains shall be the nominal mains voltage. For the purpose of this ETS, the nominal voltage shall be the declared voltage, or any of the declared voltages, for which the equipment was designed.

The frequency of the test power source corresponding to the ac mains shall be between 49 Hz and 51 Hz.

5.3.2.2 Regulated lead-acid battery power sources

When the radio equipment is intended for operation with the usual types of regulated lead-acid battery power source, the normal test voltage shall be 1,1 multiplied by the nominal voltage of the battery (e.g. 6 volts, 12 volts etc.).

5.3.2.3 Other power sources

For operation from other power sources or types of battery (primary or secondary), the normal test voltage shall be that declared by the equipment applicant and approved by the test laboratory. Such values shall be stated in the test report.

5.4 Extreme test conditions

5.4.1 Extreme temperatures

5.4.1.1 Procedure for tests at extreme temperatures

Before measurements are made the equipment shall have reached thermal balance in the test chamber. The equipment shall be switched off during the temperature stabilising period.

In the case of equipment containing temperature stabilisation circuits designed to operate continuously, the temperature stabilisation circuits shall be switched on for 15 minutes after thermal balance has been obtained, and the equipment shall then meet the specified requirements.

If the thermal balance is not checked by measurements, a temperature stabilising period of at least one hour, or such period as may be decided by the accredited test laboratory, shall be allowed. The sequence of measurements shall be chosen, and the humidity content in the test chamber shall be controlled so that excessive condensation does not occur.

5.4.1.1.1 Procedure for equipment designed for continuous operation

If the applicant states that the equipment is designed for continuous operation, the test procedure shall be as follows:

- before tests at the upper extreme temperature the equipment shall be placed in the test chamber and left until thermal balance is attained. The equipment shall then be switched on in the transmit condition for a period of a half hour after which the equipment shall meet the specified requirements;

- for tests at the lower extreme temperature, the equipment shall be left in the test chamber until thermal balance is attained, then switched on for a period of one minute after which the equipment shall meet the specified requirements.

5.4.1.1.2 Procedure for equipment designed for intermittent operation

If the applicant states that the equipment is designed for intermittent operation, the test procedure shall be as follows:

- before tests at the upper extreme temperature the equipment shall be placed in the test chamber and left until thermal balance is attained in the oven. The equipment shall then either:

  - transmit on and off according to the applicants declared duty cycle for a period of five minutes; or

  - if the applicant's declared on period exceeds one minute, then:

  - transmit in the on condition for a period not exceeding one minute, followed by a period in the off or standby mode for four minutes after which the equipment shall meet the specified requirements.

- for tests at the lower extreme temperature, the equipment shall be left in the test chamber until thermal balance is attained, then switched to the standby or receive condition for one minute after which the equipment shall meet the specified requirements.

5.4.1.2 Extreme temperature ranges

For tests at extreme temperatures, measurements shall be made in accordance with the procedures specified in subclause 5.4.1.1, at the upper and lower temperatures of one of the following ranges:

Category I (General): - 25°C to + 55°C.

Category II (Portable): - 10°C to + 55°C.

Category III (Equipment for normal indoor use): 0°C to + 55°C.

NOTE: The term "Equipment for normal indoor use" is taken to mean the minimum indoor temperature is equal to or greater than 5°C.

For special applications, the manufacturer can specify wider temperature ranges than given as a minimum above. This shall be reflected in manufacturers product literature.

The test report shall state which range is used.

5.4.2 Extreme test source voltages

5.4.2.1 Mains voltage

The extreme test voltages for equipment to be connected to an ac mains source shall be the nominal mains voltage ± 10 %.

5.4.2.2 Regulated lead-acid battery power sources

When the radio equipment is intended for operation from the usual type of regulated lead-acid battery power sources the extreme test voltages shall be 1,3 and 0,9 multiplied by the nominal voltage of the battery (6 volts, 12 volts, etc.).

5.4.2.3 Power sources using other types of batteries

The lower extreme test voltages for equipment with power sources using batteries shall be as follows:

- for equipment with a battery indicator, the end point voltage as indicated;

- for equipment without a battery indicator the following end point voltages shall be used:

  - for the Leclanché or the lithium type of battery:
    0,85 multiplied by the nominal voltage of the battery

  - for the nickel-cadmium type of battery:

0,9 multiplied the nominal voltage of the battery

- for other types of battery or equipment, the lower extreme test voltage for the discharged condition shall be declared by the equipment applicant.

The nominal voltage is considered to be the upper extreme test voltage in this case.

5.4.2.4 Other power sources

For equipment using other power sources, or capable of being operated from a variety of power sources, the extreme test voltages shall be those agreed between the equipment applicant and the accredited test laboratory and shall be recorded in the test report.

6 General conditions

6.1 Normal test signals and test modulation

The test modulating signal is a signal which modulates a carrier and is dependent upon the type of equipment under test and also the measurement to be performed. Modulation test signals only apply to products with an external modulation connector. For equipment without an external modulation connector, normal operating modulation shall be used.

6.1.1 Normal test signals for analogue speech

A-M1: a 1 000 Hz tone;
A-M2: a 1 250 Hz tone.

The level of the test signals A-M1 and A-M2 shall be adjusted to produce a deviation of 12 % of the channel separation or if a deviation of 12 % cannot be achieved, the maximum deviation as declared by the applicant.

In the case of amplitude modulation, the modulation depth shall be 60 % or if 60 % cannot be achieved the maximum modulation depth as declared by the applicant.

6.1.2 Normal test signals for data

D-M2: a test signal representing a pseudo-random bit sequence of at least 511 bits in accordance with CCITT Recommendation O.153 [5]. This sequence shall be continuously repeated. If the sequence cannot be continuously repeated, the actual method used shall be stated on the test report.

D-M3: a test signal shall be agreed between the accredited test laboratory and the applicant in case selective messages are used and are generated or decoded within the equipment.

The normal level of the test signal D-M3 shall produce a deviation of 20 % of the channel separation or any other value as declared by the applicant as the normal operating level. In case of amplitude modulation, the modulation ratio shall be 60 %, or any lower value, as declared by the applicant, as the normal operating level.

6.2 Artificial antenna

Where applicable, tests shall be carried out using an artificial antenna.

6.2.1 Artificial antenna for inductive transmitters (non 50 ohm)

For measurements at inductive transmitters without a 50 ohm antenna impedance, a tuned reduced radiating load connected to the antenna connector shall be used as agreed with the test laboratory.

The impedance shall be equal to the nominal load of the equipment specified by the applicant.

This method facilitates conducted measurements to be made as the following:

- transmitter carrier loop currents up to 30 MHz; and
- transmitter spurious loop currents up to 30 MHz
- conducted spurious measurements in the range 30 MHz - 1 GHz.

The use this non- 50 ohm load during test shall be stated in the test report form.

6.2.2 Artificial antenna for transmitters with 50 ohm impedance connector

For measurements on transmitters with a normal 50 antenna impedance, tests shall be carried out using an artificial antenna which shall be substantially non-reactive non-radiating load with a 50 ohm connected to the antenna connector. The Voltage Standing Wave Ratio (VSWR) at the 50 ohm connector shall not be greater than 1,2:1 over the frequency range of the measurement.

6.3 Test fixture

With equipment intended for use with an integral antenna, and not equipped with a 50 ohm RF output connector the applicant shall supply a test fixture.

This fixture is a radio frequency coupling device for coupling the integral antenna to a 50 ohm RF terminal at the working frequencies of the equipment under test. This allows certain measurements to be performed using conducted measuring methods. However, only relative measurements may be performed.

The test fixture shall be fully described by the applicant.

The test laboratory shall calibrate the test fixture by carrying out the required field measurements at normal temperatures at the prescribed test site and then by repeating the same measurements on the equipment under test using the test fixture for all identified frequency components.

The test fixture is only required for extreme temperature measurements and shall be calibrated only with the equipment under test.

In addition, the test fixture may provide:

- a connection to an external power supply
- an audio or data interface either by direct connection or by an acoustic coupler.

The performance characteristics of the test fixture shall be agreed upon with the accredited test laboratory and shall conform to the following basic parameters:

- the circuit associated with the RF coupling shall contain no active circuitry;
- the coupling loss shall not influence the measuring results;
- the coupling loss shall be independent of the position of the test fixture and be unaffected by the proximity of the surrounding objects or people;
- the coupling loss shall be reproducible when the equipment under test is removed and replaced;
- the coupling loss shall remain substantially constant when the environmental conditions are varied.

6.4 Test sites and general arrangements for radiated measurements

For guidance on radiation test sites and detailed descriptions of radiated measurement arrangements, see Annex A.

6.5 Modes of operation of the transmitter

For the purpose of the measurements according to this ETS, there should preferably be a facility to operate the transmitter in an unmodulated state. The method of achieving an unmodulated carrier frequency or special types of modulation patterns may also be decided by agreement between the applicant and the accredited test laboratory. It shall be described in the test report. It may involve suitable temporary internal modifications of the equipment under test. If it is not possible to provide an unmodulated carrier then this shall be stated in the test report.

For transmitters using a continuous wideband swept carrier the measurement shall be made with the sweep on.

For the purpose of type testing, the normal test signal, see subclause 6.1.1 and 6.1.2, shall be applied to the input of the transmitter under test with the normal input device disconnected (e.g. microphone).

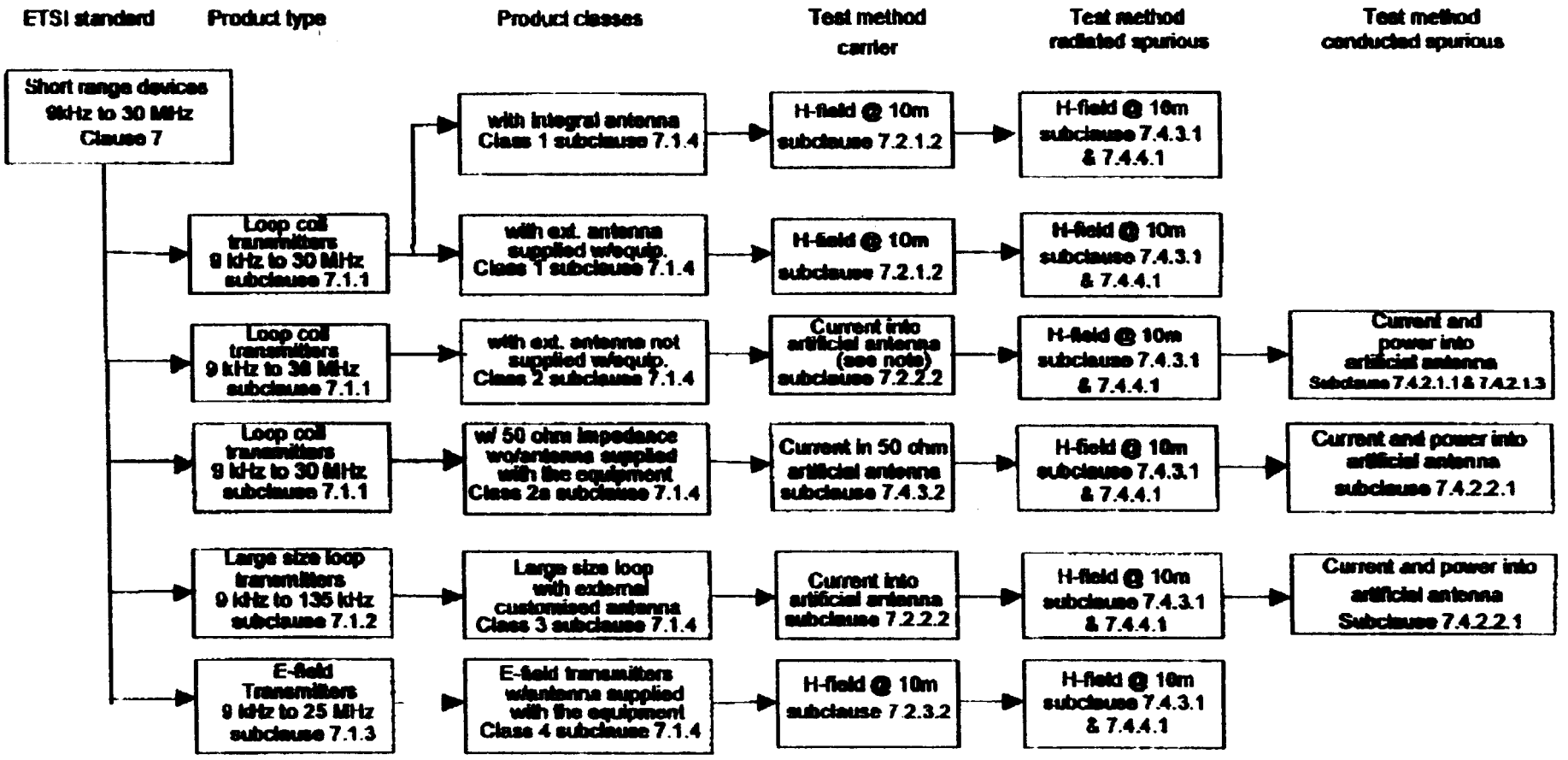
6.6 Measuring receiver

The term "measuring receiver" refers to a selective voltmeter or a spectrum analyser. The bandwidth and detector type of the measuring receiver are given in table 1.

Table 1

Frequency: (f)	Detector type:	Bandwidth:
9 kHz ≤ f < 135 kHz	Quasi Peak	200 - 300 Hz
135 kHz ≤ f < 30 MHz	Quasi Peak	9 -10 kHz
30 MHz ≤ f ≤ 1000 MHz	Quasi Peak	100 - 120 kHz

Transmitter requirements, overview



NOTE: The artificial antenna supplied by the manufacturer shall be equivalent to antenna with the maximum magnetic moment intended to be used with the product

Figure 1

7 Transmitter requirements

To meet the requirements of this ETS the transmitter shall be measured at the power level as declared by the applicant.

Where the transmitter is designed with an adjustable carrier power, all parameters shall be measured using the highest output level as declared by the applicant. The equipment shall then be adjusted to the lowest setting, as declared by the applicant, and the spurious emissions measurement shall be repeated (see subclause 7.4).

When making transmitter tests on equipment designed for intermittent operation, the duty cycle of the transmitter, as declared by the applicant on the application form, shall not be exceeded. The actual duty cycle used shall be stated on the test report form.

If the equipment is supplied with both a permanent 50 ohm antenna connector and a dedicated antenna the full tests shall be carried out using the external connector and in addition:

- effective radiated power (radiated) (see subclauses 7.2.2.);
- spurious emissions (see subclause 7.2.2. and annex A)

tests shall be carried out with the dedicated antenna

7.1 Transmitter definitions

Transmitters are divided into classes based on their radiated field and antenna type to be used. Transmitters type tested without an antenna may allow the customer to use his own loop antenna design based on the manufacturers design guidelines. The user's manual shall include the guidelines for the design of the antennas.

7.1.1 The inductive loop coil transmitters

These transmitters are characterised by:

a) the loop coil antenna area A shall be < 30 m^2,

b) the circumference of any loop of the antenna shall be $< \frac{\lambda}{2\pi}$ ($< \frac{47,7}{f}$, where f is in MHz)

c) antenna coil may have one or multiple turns.

7.1.2 The large size loop transmitters

These transmitters are characterised by:

- large loop antenna area A > 30 m^2;
- large loop antenna with one turn only;
- frequency range limited to 9 kHz to 135 kHz only.

7.1.3 Other transmitters

These transmitters are characterised as either:

- E-field transmitters, or;
- Representative site measurements in accordance with this ETS

7.1.4 Product classes

The product classes are:

Class 1: Inductive loop coil transmitter, type tested with an integral antenna; this means tested with either an integrated antenna or an external antenna supplied with the equipment.

NOTE 1: The transmitter carrier and spurious are limited by the maximum generated H-field. (see subclause 7.2.1.3 and subclauses 7.4.3.2 and 7.4.4.2 respectively).

Where a manufacturer provides a range of standard antennas the equipment will be type tested as class 1 equipment, with the antenna(s) attached.

Class 2: Inductive loop coil transmitter, type tested without an antenna.

NOTE 2: This class of equipment is intended for use with customised antennas only. The transmitter carrier and spurious are limited by the maximum output loop current, (see subclause 7.2.2.3 and subclauses 7.4.2.1.2, 7.4.2.1.4 7.4.3.2 and 7.4.4.2 respectively).

Class 2a: Inductive loop transmitter, type tested with a 50 ohm impedance connector.

NOTE 2a: The transmitter carrier and spurious are limited by the conducted power and radiated H-field, (see subclauses 7.4.2.3 and 7.4.4.2 respectively.)

Class 3: large size inductive loop transmitter, type tested without an antenna.

NOTE 3: The transmitter carrier and spurious are limited by the maximum output loop current, (see subclauses 7.2.2.3 and subclauses 7.4.2.1.2, 7.4.2.1.4 7.4.3.2 and 7.4.4.2 respectively).

Class 4: E-field transmitter, type tested with each type of antenna to be used.

NOTE 4: The transmitter carrier and spurious are limited by the maximum generated E-field, measured as the equivalent H-field, (see subclause 7.2.3.3 and subclauses 7.4.3.2 and 7.4.4.2 respectively).

For transmitter requirement overview see figure 1.

7.2 Transmitter carrier output levels

7.2.1 H-field (Class 1) (radiated)

7.2.1.1 Definition

In the case of a transmitter with an integral antenna the H-field is measured in the direction of maximum field strength under specified conditions of measurement.

7.2.1.2 Methods of measurement

The H-field produced by the equipment shall be measured at a standard distance of 10 metres on an open field test site as specified in annex A.

The H-field is measured with a shielded loop antenna connected to a measurement receiver. The measuring bandwidth and detector type of the measurement receiver shall be in accordance with subclause 6.6.

The equipment under test shall operate where possible, without modulation. Where this is not possible it shall be stated in the test report.

For transmitters using a continuous wideband swept carrier the measurement shall be made with the sweep on.

For inductive transmitters having an antenna system performing a distance cancellation effect (increased attenuation with distance), the applicant may have the carrier H-field measured at 30 metres distance.

If a 30 m measuring distance is used during the test this shall be stated in the application and test report forms.

This 30 m test distance is only valid for the carrier frequency, other frequencies incl. spurious components shall be measured at the normal distance of 10 metres.

For measuring equipment calibrated in dBµV, the reading should be reduced by 51.6 dB to be converted to dBµA/m.

7.2.1.3 Limits

The limits presented in this ETS are the required field strengths to allow satisfactory operation of inductive systems. These levels were determined after careful analysis within ETSI and ERC/CEPT.

Exceptionally, some National Administrations may have a need for SRDs to apply lower field strengths at particular frequencies in the bands indicated, in order to protect existing primary services. In order to take account of these requirements a level is indicated which shall be the minimum value of the limit to be applied at those particular frequencies. Maximum field strength under normal and extreme conditions are given in tables 2a and 2b below.

Table 2a: H-field limits

Frequency range (MHz)	H-field strength limit (Hy) dBµA/m at 10 m
$0,009 \le f < 0,03$	72 or according to NOTE 1 and/or NOTE 2
$0,03 \le f < 0,07$ $0,119 \le f < 0,135$	72 at 0,03 MHz descending 3 dB/oct or according to NOTE 1 and/or NOTE 2
$0,07 \le f < 0,119$	42
$0,135 \le f < 1,0$	37,7 at 0,135 MHz descending 3 dB/oct
$1,0 \le f < 10$	29 at 1,0 MHz descending 9 dB/oct. NOTE 3
$10 \le f < 30$	-1 NOTE 3
$6,765 \le f \le 6,795$ $13,553 \le f \le 13,567$ $26,957 \le f \le 27,283$	42

NOTE 1: The minimum limit to be applied at particular frequencies to protect existing services within these indicated bands is 42 dBµA/m at 10 m

NOTE 2: For the frequency ranges 9 - 70 kHz and 119 - 135 kHz, the following additional restrictions apply to the higher limits:

- for loop coil antennas with an area ≥ 0,16 m² table 2a applies directly;
- for loop coil antennas with an area between 0,05 m² and 0,16 m² table 2a applies with a correction factor. The limit is: table value + 10 *log (area/0,16 m²)
- for loop coil antennas with an area < 0,05 m² the limit is 10 dB below table 2a;

NOTE 3: For certain applications within specific frequency bands the limits may be up to [20] dBµA/m.
(Subject to CEPT/ERC approval)

For a graphical representation of table 2a, see Annex B.

Carrier limits for a measuring distance of 30 metres are given in Table 2b below:

Table 2b: H-field limits at 30 m

Frequency range (MHz)	H-field strength limit (H_0) dBμA/m at 30 m
0.009 ≤ f < 0.03	43.5 or according to NOTE1 and /or NOTE 2
0.03 ≤ f < 0.07 0.119 ≤ f < 0.135	43.5 at 0.03 MHz descending 3 dB/oct or according to NOTE1 and /or NOTE 2
0.07 ≤ f < 0.119	13.6
0.135 ≤ f < 2.0	9.7 at 0.135 MHz descending 3 dB/oct NOTE 3
2.0 ≤ f < 3.7	-3 at 2.0 MHz descending 9 dB/oct. NOTE 3
3.7 ≤ f < 30	-11 NOTE 3
6.765 ≤ f ≤ 6.795 13.553 ≤ f ≤ 13.567 26.957 ≤ f ≤ 27.283	32.5

NOTE 1 The minimum limit to be applied at particular frequencies to protect existing services within these indicated bands is 13.5 dBμA/m at 30 m.

NOTE 2 For the frequency ranges 9 - 70 kHz and 119 - 135 kHz, the following additional restrictions apply to the higher limits:

- for loop coil antennas with an area ≥ 0,16 m^2 table 2b applies directly;
- for loop coil antennas with an area between 0,25 m^2 and 0,16 m^2 table 2b applies with a correction factor. The limit is table value + 10 log (area/0,16m^2)
- for loop coil antennas with an area < 0,25 m^2 the limit is 10 dB below table 2b;

NOTE 3 For certain applications within specific frequency bands the limits may be up to [72.5] dBμA/m.
(Subject to CEPT/ ERC approval)

For a graphical representation of table 2b, see Annex B.

7.2.2 RF carrier current (Classes 2 and 3)

7.2.2.1 Definition

The RF carrier current is defined as the current delivered to an artificial load under specified conditions of measurement.

7.2.2.2 Methods of measurement

The transmitter shall be connected to an artificial antenna, see subclause 6.2.1. The RF current delivered to this artificial antenna during a transmission duty cycle shall be measured up to 30 MHz using a calibrated current test fixture connected to a measuring receiver.

The measuring bandwidth and detector type shall be in accordance with subclause 6.6.

For transmitters using a continuous wideband swept carrier the measurement shall be made with the sweep on.

This method of measurement for the transmitter carrier current is used for:

- class 2 equipment operating at a frequency up to 30 MHz.

- class 3 equipment operating at a frequency up to 135 kHz.

The measurements shall be made under normal and extreme test conditions, see subclause 5.4.

The relation between carrier current and antenna dimensions is given in Annex H.

7.2.2.3 Limits

7.2.2.3.1 Class 2:

a) RF carrier current:

the measured value of RF carrier current shall be within 1,5 dB of the value declared by the applicant, without exceeding the declared value.

b) equivalent H-field:

The maximum field strength is given in table 2.

The H-field is not required to be measured, in order to obtain the initial type testing, however, if the equipment is subsequently required to be tested, then measurements shall be made, with the customised antenna fitted, in accordance with subclause 7.2.1.2 and shall not exceed the limits as stated in subclause 7.2.1.3.

The type testing will be to a specific maximum RF carrier current, as declared by the manufacturer on the appropriate application form. This will allow the manufacturer to supply customised antenna based on the minimum antenna factor, for a given maximum RF current, obtained from annex H, figure H.1. Customer designed antennas shall be approved by the manufacturer or the manufacturer's representative.

A detailed explanation on the relationship between the RF carrier current, antenna factor (N°A) and the equivalent generated H-field is given in annex H.

7.2.2.3.2 Class 3

The maximum RF carrier current limit for Large size loop transmitters is given in table 3

Table 3: RF carrier current

Frequency range MHz	RF carrier current dBµA
0,009 - < 0,03	115,6
0,03 ≤ f < 0,07 0,119 ≤ f < 0,135	115,6 at 30 kHz descending 3,5 dB/oct
0,07 ≤ f < 0,119	85,6

See annex C for a graphical representation.

7.2.3 Radiated E-field (Class 4)

7.2.3.1 Definition

The radiated E-field is defined as the E-field in the direction of maximum field strength under the specified conditions of measurement. This is defined for a transmitter with an integral antenna..

7.2.3.2 Methods of measurement

The transmitter radiated E-field, is based on the equivalent measured H-field, measured at 10 m.

The H-field is measured with a shielded loop antenna connected to a measurement receiver. The measuring bandwidth and detector type of the measurement receiver shall be in accordance with subclause 6.6.

For a detailed explanation of the relationship between E-field and H-field, see annex G.

7.2.3.3 Limits

In the frequency range 9 kHz to 4,78 MHz, the limits of H_M follow the H-fields limits, H_t, as given in subclause 7.2.1.3, table 2 with an additional correction factor C. The factor given below is specific for a 10 m measuring distance.

The limit $H_M = H_t + C$;

where:

$C = 20 * \log (f_c / 4,78 * 10^6)$ dB;

and where:

f_c is the carrier frequency in Hz.

For a graphical representation of the correction factor C see annex D.

In the frequency range 4,78 MHz - 25 MHz limits are identical to the limits in subclause 7.2.1.3, table 2 without any correction factor.

7.3 Permitted frequency range of the total modulation bandwidth

The permitted frequency range shall be stated by the applicant.

7.3.1 Definition

The permitted range of the total modulation bandwidth contain all associated side bands above the following level:

a) for frequencies below 135 kHz at the highest level of either:

- 30 dB below the carrier or;
- at the appropriate spurious limit

b) for frequencies in the range 135 kHz - 30 MHz:

- at the appropriate spurious limit

Where the assigned frequency band has been divided into in to sub-bands the above measuring levels and bandwidths apply at the sub-band limits.

7.3.2 Method of measurement

The transmitter shall be connected to an artificial antenna or if the transmitter has an integral antenna a test fixture shall be used (see subclause 6.3). The RF output of the equipment shall be connected to a spectrum analyser via a 50 ohm variable attenuator.

The transmitter shall be operated at the nominal carrier power or field strength measured under normal test conditions in subclause 7.2. The attenuator shall be adjusted to an appropriate level displayed at the spectrum analyser screen.

The transmitter shall be modulated with standard test modulation (see subclause 6.1.1 and 6.1.2). If the equipment cannot be modulated externally, the internal modulation shall be used.

For transmitters using a continuous wideband swept carrier the measurement shall be made with the sweep on.

The output of the transmitter, with or without test fixture, shall be used using a spectrum analyser resolution bandwidth large enough to accept all major side bands. The power level calibration of the spectrum analyser shall then be related to the power level or field strength measured in subclause 7.2. The calculation will be used to calculate the absolute level of the sideband power.

The test laboratory shall ensure that the spectrum analyser's span is sufficiently wide enough to ensure that the carrier and all its major side bands are captured.

The frequencies of the upper and lower points, where the displayed power envelope of the modulation including frequency drift is equal to the appropriate level defined in subclause 7.3.1 is recorded as the modulation bandwidth.

The measurements shall be made during normal and extreme test conditions (subclauses 5.4.1 and 5.4.2 applied simultaneously).

7.3.3 Limits

The permitted range of the modulation bandwidth shall be within the limits of the assigned frequency band.

7.4 Spurious emissions

7.4.1 Definition

Spurious emissions are emissions at frequencies other than those of the carrier and sidebands associated with normal test modulation (subclause 6.1). The level of spurious emissions shall be measured at normal conditions (subclause 5.3) as either:

1) a) their power or current level in an artificial antenna (conducted spurious emissions); and

   b) their effective radiated power or field strength when radiated by the cabinet and structure of the equipment (cabinet radiation);

or

2) their effective radiated power or field strength when radiated by the cabinet and the integral antenna, in the case of portable equipment fitted with such an antenna and no external RF connector.

7.4.2 Conducted spurious emissions, subclause 7.4.1; indent 1 a)

7.4.2.1 Class 2

7.4.2.1.1 Methods of measurement (< 30 MHz)

The transmitter shall be connected to an artificial antenna according to subclause 6.2.1. The measuring receiver shall be connected to the output of the artificial antenna and the current for both the carrier and the spurious components shall be measured. For further details of the artificial antenna, see Annex F.

The spurious current limit I_s is calculated by the following formula:

$$I_c - I_s = H_c - H_s ;$$

where:

I_s is the calculated conducted spurious current limit expressed in dBµA;

I_c is the measured RF carrier current limit expressed in dBµA, see subclause 7.2.2.3.1 a);

H_c is the limit for the generated H-field expressed in dBµA/m, see subclause 7.2.1.3;

H_s is the limit for H-field spurious expressed in dBµA/m, see subclause 7.4.3.2.

The term $(H_c - H_s)$ in the above formula is the required attenuation in dB of the spurious H -field. This requirement may vary with frequency due to varying limits with frequency.

The term $(I_c - I_s)$ (in dB) is the attenuation in dB of the spurious current below the carrier current.

7.4.2.1.2 Limits

Under normal test conditions the following condition shall be fulfilled:

$$(I_c - I_s) > (H_c - H_s)$$

7.4.2.1.3 Methods of measurement (≥ 30 MHz)

The transmitter shall be connected to an artificial antenna according to subclause 6.2.2. The spurious components are measured by means of a selective voltmeter connected to the output of the transmitter by means of an appropriate coupling device.

7.4.2.1.4 Limits

The power of any conducted spurious emission shall not exceed the values given in table 4 below.

Table 4

State	47 MHz to 74 MHz 87,5 MHz to 118 MHz 174 MHz to 230 MHz 470 MHz to 862 MHz	Other Frequencies between 30 to 1000 MHz
Operating	4 nW	250 nW
Standby	2 nW	2 nW

7.4.2.2 Class 3 and Class 5

7.4.2.2.1 Methods of measurement

Spurious emissions shall be measured as the power level of any discrete signal delivered into a nominal non-reactive load. This may be done by connecting the transmitter output through an attenuator to a measuring receiver.

The transmitter shall be switched on with normal modulation and the measurements shall be made, in the frequency range 135 kHz - 1 GHz.

Where applicable, the measurements shall be repeated with the transmitter on standby.

7.4.2.2.2 Limits

The power of any conducted spurious emission below 30 MHz shall not exceed the values given in table 5.

The power of any conducted spurious emission at, or above, 30 MHz shall not exceed the values given in table 4.

Table 5

State	135 to 1 000 kHz	1 000 kHz to 30 MHz
Operating	1 µW	250 nW
Standby	2 nW	2 nW

7.4.3 Field strength, subclause 7.4.1; indent 1 b) and 2)

7.4.3.1 Methods of measurement (< 30 MHz)

This applies to all Classes.

The field strength shall be measured for frequencies below 30 MHz. The equipment under test shall be measured at a distance of 10 m on an outdoor test site. The test antenna shall be a calibrated shielded magnetic field antenna. The equipment under test and test antenna shall be arranged as stated in annex A, clause A.1.

For Classes 2 and 3 the transmitter antenna connector of the equipment under test shall be connected to an artificial antenna (see subclause 6.2) and the output connector terminated.

The equipment under test shall be switched on with normal modulation. The characteristics of the modulation signal used shall be stated on the test report. The measuring receiver shall be tuned over the frequency range 9 kHz to 30 MHz, except for the frequency band on which the transmitter is intended to operate.

At each frequency at which a spurious signal is detected the equipment under test and the test antenna shall be rotated until maximum field strength is indicated on the measuring receiver. This level shall be noted.

If the transmitter can be operated in the standby mode, then the measurements shall be repeated in the standby mode.

Convert reading by 51,5 dB for measuring equipment calibrated in dBµV or dBµV/m.

7.4.3.2 Limits

Radiated emissions below 30 MHz shall not exceed the generated H-field dBµA/m at 10 metres given in table 6.

Table 6

State	Frequency 9 kHz ≤ f < 4,78 MHz	Frequency 4,78 MHz ≤ f < 30 MHz
Transmit	34,5 dBµA/m descending 3 dB/oct	-2,8 dBµA/m
Standby	3,5 dBµA/m descending 3 dB/oct	-23,7 dBµA/m

For a graphical representation see annex E.

7.4.4 Effective radiated power, subclause 7.4.1 1., b) and 2)

7.4.4.1 Methods of measurement (≥ 30 MHz)

This method applies to all Classes

.On a test site, selected from annex A, the equipment shall be placed at the specified height on a non-conducting support and in the position closest to normal use as declared by the applicant.

For Classes 2 and 3 the transmitter antenna connector shall be connected to an artificial antenna (see subclause 6.2).

The test antenna shall be oriented for vertical polarisation. The output of the test antenna shall be connected to a measuring receiver.

The transmitter shall be switched on with normal modulation, and the measuring receiver shall be tuned over the frequency range 30 to 1 000 MHz.

At each frequency at which a spurious component is detected, the test antenna shall be raised and lowered through the specified range of heights until a maximum signal level is detected on the measuring receiver.

The transmitter shall then be rotated through 360° in the horizontal plane, until the maximum signal level is detected by the measuring receiver.

The maximum signal level detected by the measuring receiver shall be noted.

The substitution antenna shall be oriented for vertical polarisation and calibrated for the frequency of the spurious component detected.

The frequency of the calibrated signal generator shall be set to the frequency of the spurious component detected. The input attenuator setting of the measuring receiver shall be adjusted in order to increase the sensitivity of the measuring receiver, if necessary.

The test antenna shall be raised and lowered through the specified range of heights to ensure that the maximum signal is received.

When a test site according to annex A, clause A.3 is used, there is no need to vary the height of the antenna.

The input signal to the substitution antenna shall be adjusted until an equal or a known related level to that detected from the transmitter is obtained on the measuring receiver.

The input signal to the substitution antenna shall be recorded as a power level and corrected for any change of input attenuator setting of the measuring receiver.

The measurement shall be repeated with the test antenna and the substitution antenna oriented for horizontal polarisation.

The measure of the effective radiated power of the spurious components is the larger of the two power levels recorded for each spurious component at the input to the substitution antenna, corrected for the gain of the substitution antenna if necessary.

If an unmodulated carrier cannot be obtained then the measurements shall be made with the transmitter modulated by the normal test signal D-M3 (see subclause 6.1.2) in which case this fact shall be recorded in the test report.

If standby mode is available, the measurements shall be repeated in that mode.

7.4.4.2 Limits

The power of any radiated emission shall not exceed the values given in table 7 below

Table 7

State	47 MHz to 74 MHz 87,5 MHz to 118 MHz 174 MHz to 230 MHz 470 MHz to 862 MHz	Other frequencies between 30 to 1000 MHz
Operating	4 nW	250 nW
Standby	2 nW	2 nW

8 Receiver requirement

8.1 Receiver spurious radiation

These requirements do not apply to receivers used in combination with permanently co-located transmitters continuously transmitting. Co-located is defined as < 3 m. In these cases the receivers will be tested together with the transmitter in operating mode (see subclause 7.4).

8.1.1 Definition

Spurious radiation from receivers are emissions radiated from the antenna, the chassis and case of the receiver. It is specified as the radiated power of a discrete signal.

8.1.2 Methods of measurement

1) For radiation below 30 MHz see subclause 7.4.3.1.

2) For radiation at or above 30 MHz see subclause 7.4.4.1.

Convert reading by 51,5 dB for measuring equipment calibrated in dBµV or dBµV/m.

8.1.3 Limits

8.1.3.1 Radiated emissions below 30 MHz:

The spurious components below 30 MHz shall not exceed the generated H-field dBµA/m values at 10 metres according to table 8.

Table 8

Frequency 9 kHz ≤ f < 4,78 MHz	Frequency 4,78 MHz ≤ f < 30 MHz
3,5 dBµA/m descending 3 dB/oct	- 23,7 dBµA/m

For a graphical representation see annex E.

8.1.3.2 Radiated emissions above 30 MHz:

The measured values shall not exceed 2 nW.

9 Measurement uncertainty

The accumulated measurement uncertainties of the test system in use for the parameters to be measured should not exceed those given below, this is in order to insure that the measurements remain within an acceptable standard.

RF frequency ± 1×10^{-7}

RF power, conducted	± 0,75 dB
RF power, radiated	± 6 dB
Temperature	± 1°C
Humidity	± 5 %

For the test methods according to this ETS the uncertainty figures are valid to a confidence level of 95 % calculated according to the methods described in the ETR 028 [6].

Annex A (normative): Radiated measurements

A.1 Test sites and general arrangements for measurements involving the use of radiated fields

A.1.1 Outdoor test site

The outdoor test site shall be on a reasonably level surface or ground. For measurements at frequencies below 30 MHz a low permeability (non-iron based) ground plane shall be used. For measurements at frequencies 30 MHz and above, a conducting ground plane of at least 5 m diameter shall be provided at one point on the site. In the middle of this ground plane, a non-conducting support, capable of rotation through 360° in the horizontal plane, shall be used to support the test sample in its standard position, at 1 m above the ground plane, with the exception of equipment with floor standing antenna. For this equipment, the antenna shall be raised, on a non-conducting support, 100 mm above the turntable, the point(s) of contact being consistent with normal use. The test site shall be large enough to allow the erection of a measuring or transmitting antenna at a distance of 10 m. The distance actually used shall be recorded with the results of the tests carried out on the site.

Sufficient precautions shall be taken to ensure that reflections from extraneous objects adjacent to the site do not degrade the measurements results.

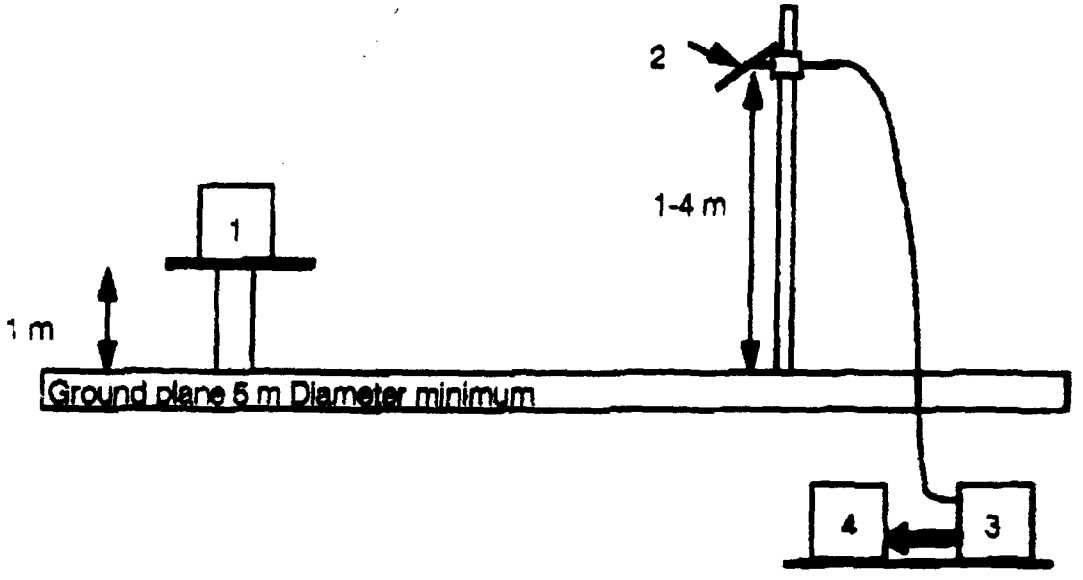


Figure A.1

A.1.1.1 Test support for body worn equipment

For equipment intended to be worn close the body, but excluding hand-held equipment, the non-conducting support shall be replaced with the simulated man.

The simulated man shall consist of a plastic tube, filled with salt water (9 grams NaCl per litre). The tube shall have a length of 1 m and an internal diameter of 10 cm ± 0,5 cm. The upper end of the tube is closed by a metal plate with a diameter of 15 cm, which is in contact with the water. To meet the requirements made on equipment with rigid outside antenna, this antenna has to be in a vertical position during the measurement and the metal plate shall, if necessary, be prepared in such a way that a second hinged metal plate of 10 cm x 15 cm can be fastened to its narrow side. It shall be possible to change the supporting point of the hinged metal plate as far as the centre.

The position of the hinged metal plate shall be adjusted within 0° to 90° with respect to the lower metal plate.

The sample shall be fastened in such a way that:

1) the centre of its largest area rests on the revolving metal plate; and

2) this centre, on its part, is located above the centre of the lower metal plate by changing the supporting point of the revolving plate.

In the case of a sample, whose largest area is smaller than 10 cm x 15 cm, the centre of the sample shall (deviating from point 1) above) be so changed in its longitudinal axis so that the antenna base is at the edge outside the metal plate.

A.1.1.2 Standard position

The standard position in all test sites, except for equipment which is intended to be worn on a person, shall be as follows:

- for equipment with an integral antenna, it shall be placed in the position closest to normal use as declared by the manufacturer;

- for equipment with a rigid external antenna, the antenna shall be vertical;

- for equipment with non-rigid external antenna, the antenna shall be extended vertically upwards by a non-conducting support.

A.1.2 Test antenna

A.1.2.1 Below 30 MHz

A calibrated loop antenna shall be used to detect the field strength from the test sample. The antenna shall be supported in the vertical plane and be rotated about a vertical axis. The lowest point of the loop shall be 1 m above ground level.

A.1.2.2 Above 30 MHz

The test antenna is used to detect the radiation from both the test sample and the substitution antenna, when the site is used for radiation measurements. Where necessary, it is used as a transmitting antenna, when the site is used for the measurement of receiver characteristics.

This antenna is mounted on a support such as to allow the antenna to be used in either horizontal or vertical polarisation and for the height of its centre above ground to be varied over the range 1 m to 4 m. Preferably a test antenna with pronounced directivity should be used. The size of the test antenna along the measurement axis shall not exceed 20 % of the measuring distance.

For receiver and transmitter radiation measurements, the test antenna is connected to a measuring receiver, capable of being tuned to any frequency under investigation and of measuring accurately the relative levels of signals at its input.

A.1.3 Substitution antenna

When measuring in the frequency range up to 1 GHz the substitution antenna shall be a $\lambda/2$ dipole, resonant at the operating frequency, or a shortened dipole, calibrated to the $\lambda/2$ dipole. The centre of this antenna shall coincide with the reference point of the test sample it has replaced. This reference point shall be the volume centre of the sample when its antenna is mounted inside the cabinet, or the point where an external antenna is connected to the cabinet.

The distance between the lower extremity of the dipole and the ground shall not be less than 0,3 m.

The substitution antenna shall be connected to a calibrated signal generator when the site is used for spurious radiation measurements and transmitter effective radiated power measurements. The

substitution antenna shall be connected to a calibrated measuring receiver when the site is used for the measurement of receiver sensitivity.

The signal generator and the receiver shall operate at the frequencies under investigation and shall be connected to the antenna through suitable matching and balancing networks.

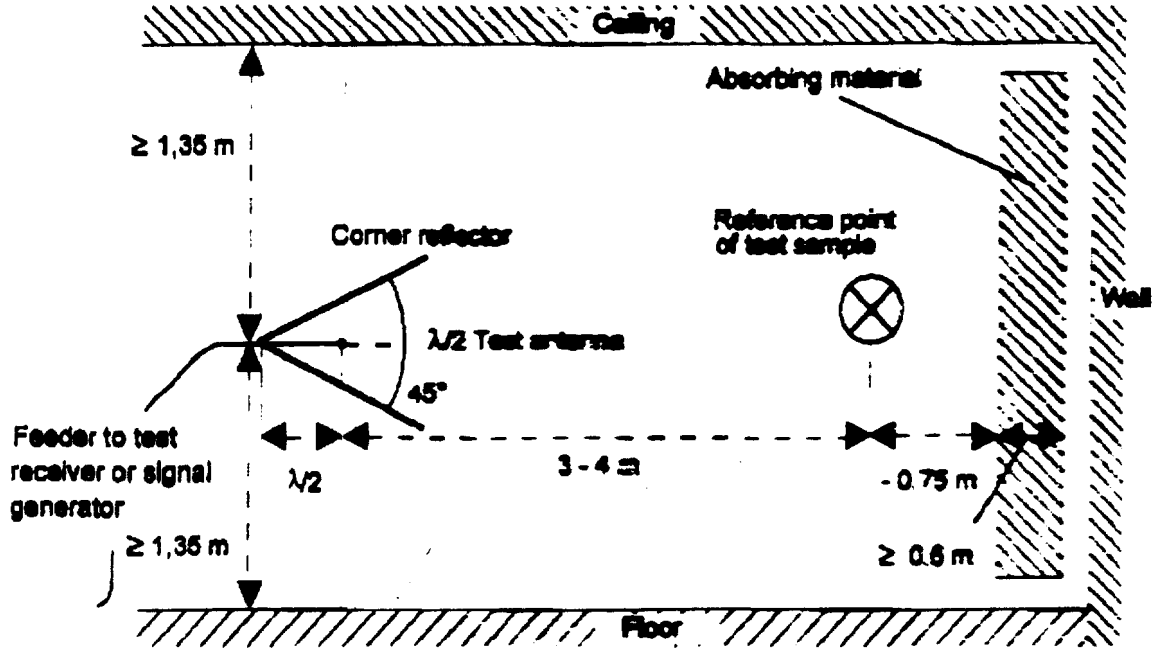


Figure A.2: Indoor site arrangement (shown for horizontal polarization)

A.1.4 Optional additional indoor site

When the frequency of the signals being measured is greater than 80 MHz, use may be made of an indoor test site. If this alternative site is used, this shall be recorded in the test report.

The measurement site may be a laboratory room with a minimum area of 6 m by 7 m and at least 2,7 m in height.

Apart from the measuring apparatus and the operator, the room shall be as free as possible from reflecting objects other than the walls, floor and ceiling.

The potential reflections from the wall behind the equipment under test are reduced by placing a barrier of absorbent material in front of it. The corner reflector around the test antenna is used to reduce the effect of reflections from the opposite wall and from the floor and ceiling. In the case of horizontally polarised measurements. Similarly, the corner reflector reduces the effects of reflections from the side walls for vertically polarised measurements. For the lower part of the frequency range (below approximately 175 MHz), no corner reflector or absorbent barrier is needed.

For practical reasons, the λ/2 antenna in figure A.2 may be replaced by an antenna of constant length, provided that this length is between λ/4 and λ at the frequency of measurement and the sensitivity of the measuring system is sufficient. In the same way, the distance of λ/2 to the apex may be varied.

The test antenna, measuring receiver, substitution antenna and calibrated signal generator are used in a way similar to that of the general method. To ensure that errors are not caused by the propagation path approaching the point at which phase cancelation between the direct and the remaining reflected signals occurs, the substitution antenna shall be moved through a distance of ± 0,1 m in the direction of the test antenna as well as in the two directions perpendicular to this first direction.

If these changes of distance cause a signal change of greater than 2 dB, the test sample should be re-aited until a change of less than 2 dB is obtained.